CANCER STUDIES

Tumors of the Brain

W. EUGENE STERN, M.D.,
Los Angeles

IT IS CUSTOMARY to present the topic of tumors of the brain according to anatomical or pathological classification. There is some merit, however, in introducing the subject in the manner in which the patient presents himself to his physician, that is, by his complaints:

1. Weakness of an extremity; progressive in nature, usually painless, and often spreading to the second limb of the same side.

2. Speech disturbances; a difficulty in formulation and expression of words or comprehension of words (dysphasia), or a defect in the articulation of words, a slurring of speech (dysarthria).

3. Defects in vision; bumping into objects in a blind field, blurring of vision or double vision, or holding the head at a tilt to correct double vision.

4. Disturbances of balance; unsteadiness, clumsiness of gait, staggering, and ataxia.

5. Disturbances of coordination and control of an extremity that is not weak; defects in the modulation of a smoothly integrated motor system.

6. Epileptic seizures, either focal or generalized; epilepsy of late onset, that is, after the third decade of life.

7. Deterioration in mentation and personality; progressive organic dementia with slowed reaction time, decreased attention span, disturbances of recent memory, retention and recall, of arithmetical reasoning, of abstraction and judgment and of planning for the future. Progressive deterioration in the level of consciousness. Deterioration in cognizance of social amenities, incontinence of urine, lethargy.

8. Lack of development or loss of secondary sexual characteristics, amenorrhea, loss of libido.

9. The onset or change of character of headache, later occurring with vomiting, blurred vision, and drowsiness.

10. The development of unilateral eye protrusion (exophthalmos) or a visible or palpable growth on the calvarium.

11. Progressive deafness (unilaterally, with or without tinnitus); unilateral facial weakness; the occurrence of two or more adjoining cranial nerve palsies.

From the Department of Surgery/Neurosurgery, University of California Medical Center, Los Angeles.

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The Diagnostic Formulation

For the purpose of diagnosis of a brain tumor, the emphasis should be placed upon the new appearance of symptoms and their progression. Remission and intermittency in the history may occur and may be confusing, but the expected pattern is that of a minimally relenting, progressively worsening complaint, and the appearance of complaints in combination in an additive way. The history may span only a few weeks in the acute problem, or it may stretch over many years, as in focal epilepsy. But the natural history of even the benign tumor of many years' standing is that the symptoms appear in an increasingly rapid fashion as the dangerous and terminal stages of the illness approach.

Many of the major complaints represent the local signature of the tumor—in contrast to the complaints of headache, vomiting, blurred vision and stupor, which are more often nonspecific and tend to occur when dislocations of the brain are combined with elevated intracranial pressure.

A complete history and general examination should precede an examination of brain function. From the clues in the history one may concentrate upon the obvious, but special attention should be given to the following items: (1) The mental status; (2) the visual apparatus (funduscopic examination and a screening form of visual field examination should be done); (3) the special senses of smell and hearing along with other cranial nerve performance; (4) speech, for content and comprehension; (5) the motor system as manifest in status of development, tone, power, coordination, and reflex performance; (6) gait and stance; (7) the sensory system; (8) the endocrine systems.

It is almost axiomatic that the location of the tumor mass determines the focal signs that are produced, and if the historical facts and objective

evidence correspond anatomically, the surgeon is well on his way to a diagnosis of its location. Signs due to generalized effects and to herniations of brain substance may provide false localizing clues.

The Diagnostic Tests

A complete roentgenographic skull series and chest study should be part of the initial examination. Specialized examinations are selected with discrimination:

1. Electroencephalography is mandatory in patients with focal epileptic discharge and is often useful for its focal slow wave pattern in other cases. It is available in all major medical centers.
2. Radioactive scanning after injection of a compound whose radioactive constituent localizes in higher concentration in tumor than in normal tissue. This is available only in special centers. The use of compounds containing the isotope of Mercury (Mercury 203) is promising.[3]
3. Audiometric and caloric examination of eighth nerve function is accomplished by use of speech audiometry and the Békèsy tests of tone distinction plus refined calorimetry and rotational tests combined with nystagmometry.
4. Clinical perimetry for quantitative charting of the fields of vision requires tangent screen and peripheral perimetry analysis.
5. Laminographic studies of the skull, especially the petrous bones give excellent delineation of complicated basal structures.

Depending upon the evidence obtained from the sources of information mentioned, the clinician utilizes specialized neuroradiologic diagnostic aids in localization of the site and occasionally in defining the nature of the tumor. These aids, consisting of special tests, are justifiable risks when dealing with a probable or even possible brain tumor. They are:

1. Angiographic visualization of the carotid and/or basilar arterial and venous systems (angiography).
2. Negative or positive contrast ventriculographic delineation (ventriculography).
3. Gaseous visualization of all intracranial cerebrospinal fluid pathways (pneumoencephalography).

Age and Site of Occurrence of Tumor Types

Knowledge of the tumor, the duration of its history and the age of the patient help in predicting the nature of the neoplasm. Table 1 demonstrates the correlation of this information into a probability aid for diagnosis.

Certain tumors tend to occur after the first one or two decades of life and are rarely found before this, notably meningiomas, neurilemmomas, hemangioblastomas and pituitary adenomas. On the con-

TABLE 1.—*Correlation of Type of Tumor with Various Sites and Age Range*

Location	*Tumors Likely to Be Encountered*	*Peak Age Range*
Cerebral Hemisphere tumors	Glioblastoma Multiforme	25-65
	Astrocytoma	25-45
	Oligodendroglioma	15-55
	Ependymoma	20-50
	Metastatic Tumors	35-65
Bilateral, interhemispheric or midline superatentorial tumors	Gliomas (Corpus callosum)	
	Teratoma (Pineal region)	first 3 decades
	Pinealoma	any decade
	Epithelial cysts	early adult life
Midline tumors of the cerebellum and brain stem	Ependymoma	2-50
	Medulloblastoma	2-30*
	Hemangioendothelioma (angioblastoma)	20-60
	Astrocytomaspongioblastoma of brain stem	2/3 in children
	Astrocytoma of vermis (1/3-2/3 cystic)	2-45
Cerebellar hemisphere	Astrocytoma (1/3-2/3 cystic)	2-45
Cerebellopontile angle	Neurilemmoma	20-65
	Meningioma	20-65
	Glioma (ependymoma)	2-50
	Epidermoid dermoid tumors	20-60
Chiasmal-suprachiasmal area	Pituitary Adenoma	20-60
	Craniopharyngioma	5-60
	Chiasmal and optic nerve gliomas	Early decades
	Meningioma (tuberculum sellae)	20-65
	Epidermoid-dermoid tumors	20-60
Meninges—all loci	Meningioma	20-65

*3/4 under 15 years.

trary the peak incidence of medulloblastomas, cerebellar sarcomas, cerebellar astrocytomas, brain stem gliomas (astrocytoma-spongioblastoma), and ependymomas occurs before puberty. Some tumors, such as the craniopharyngioma, may appear in any age group although the incidence is highest in the first three decades of life.

Tumor Behavior

The terms *malignant* and *benign* used in reference to brain neoplasia require modification from the strict pathologic definition. A primary tumor that remains sharply circumscribed and surgically separable from the surrounding brain and that does not metastasize or disseminate may be judged benign, yet if its location and attachments make excision impossible it may bring about the death of the patient. An example is a large meningioma in the olfactory groove with a sessile, basal attachment in the floor of the anterior fossa. Furthermore, an untreated histologically benign tumor may cause death if it is located so that it obstructs passage of cerebrospinal fluid or compresses the hypothalamus. An epithelial paraphysial cyst of the third ventricle obstructs the cerebrospinal fluid, and a Rathke pouch cyst (craniopharyngioma) compresses the hypothalamus. These tumors are histologically benign but if not excised do kill. Certain "malignant" primary tumors of the brain may remain quite localized within a cerebral hemisphere, and yet may histologically and in behavior represent the most pleomorphic and rapidly destructive of the glial neoplasms. The glioblastoma multiforme is such a tumor.

Thus the location of the tumor, its relationship to brain tissue and its rate of growth must be weighed, as well as its histologic appearance, in assessing the relative benignancy or malignancy. The confined environment of the cranium makes an otherwise benign tumor "malignant" from the patient's and the surgeon's point of view. A histologically benign astrocytoma of slow growth and low-grade biological performance may, because of its location, seem to be removed in a complete manner, yet eventually because of its diffuse and histologically inseparable involvement with functional neural tissue it may cause the patient's death.

Formation of cysts and the deposition of calcium seen radiologically often suggest a benign growth. However, cysts that form because of necrosis occur commonly in the glioblastoma multiforme, a rapidly progressing "malignant" tumor. The cyst from mucoid degeneration and liquefaction in the "benign" cerebellar astrocytoma is not surrounded by tumor tissue but is located as a mass in the wall of compressed nonneoplastic tissue. Occurrence of a cyst in this case is a favorable finding, as is the isolated cyst of the hemangioblastoma. Calcification within a tumor is favorable only in that it tends to exclude the diagnosis of glioblastoma multiforme, for infiltrating gliomas such as oligodendrogliomas, astrocytomas and ependymomas calcify but nevertheless defy cure, whereas eighth nerve neurilemmomas, many meningiomas, most pituitary adenomas and some dermoid-epidermoid tumors may *not* calcify but as extracerebral tumors can be totally excised and are called benign.

Treatment

The treatment of intracranial tumors has benefited by some changes of recent years: (1) Improved methods for the control of intracranial pressure—the use of osmotically active agents (such as urea and mannitol), hypothermia and positive-negative pressure anesthesia; (2) improved techniques for administering ionizing radiation; and (3) the development of chemicals that insult neoplastic tissue more than normal adult tissue. In certain areas, notably the pituitary, the availability of endocrinologic replacement therapy permits "near total" excision of neoplasms heretofore only decompressed.

A general statement on the therapy of brain tumors is of little meaning when the physician is confronted with a specific problem, for each tumor type and location constitutes a separate challenge. In this discussion we are dealing in reality with many disease entities and will therefore attempt to group types of tumor and locales in a convenient way to discuss therapy.

The Glioblastoma Multiforme

This tumor constitutes one third of the glioma group which accounts for approximately one half of primary brain tumors.

When it is located in the central portion of the cerebral hemisphere involving more than one lobe:

Operation (reoperation not indicated)

To confirm tissue diagnosis

To evacuate cystic collections

To provide internal decompression in minority of cases.

Irradiation

Some evidence of added palliation.[20]

Chemical Therapy

No established place as yet, but trials seem justified as chemicals become available. Cerebral perfusion, a formidable procedure, may be considered only after an improvement in chemicals is realized. Local infusion, however, is worthy of application today even though the drugs available are only "on trial."[4,14]

When it is located primarily in either frontotemporal or occipital poles:

Operation (reoperation rarely indicated)

To confirm tissue diagnosis

To evacuate cystic collections

To excise as much of tumor bearing lobe as is possible compatible with useful convalescence.

Irradiation

Some evidence of added palliation.[20]

Chemical Therapy

No established place as yet but trials seem justified as chemicals become available, just as with tumors of central location.

Survival with this family of tumors is short. German reported all of 183 patients with glioblastoma multiforme dead four years postoperatively and more than 90 per cent dead in 18 months.[7] Bouchard reported the average survival at 15.8 months with 10.7 per cent surviving four years.[1] Roth and Elvidge reported 3 per cent to have survived five years.[20] Grant reported no survivals beyond five years in 188 patients.[8]

The Astrocytoma

This tumor constitutes over one half of the gliomas.

When it is located in the cerebral hemisphere in the central portion thereof involving lobes in combination:

Operation (reoperation to provide internal decompression may be indicated)

To confirm tissue diagnosis

To evacuate central portion of solid tumor including cystic portions. No excision indicated for the diffuse, noncystic lesion.

Irradiation

Indicated in almost all such tumors except the most low-grade, "benign" forms.

Chemical Therapy

Not useful at present.

When it is located primarily in a frontal, temporal, or occipital pole:

Operation (reoperation may be indicated)

To confirm tissue diagnosis

To excise in block fashion as much tumor as possible in hopes of complete excision.

Irradiation

Indicated in almost all as in that occurring in more than one lobe.

Chemical Therapy

Not useful at present.

Although the astrocytoma is classified by some as radioresistant,[30] both German and Bouchard recommended radio-therapy and together with Uihlein reported improved survival rates when irradiation is employed as well as surgical excision.[1,31] German considers cures possible in 10 per cent of tumors in this location and a 20 per cent survival to five years. These cerebral astrocytomas may show spurts of growth suggestive of a change in biological behavior and may assume the character of the glioblastoma multiforme following a life of many years as judged by history and evidence of long-standing calcification.

When it is located in the cerebellum:

Such tumors are cystic in one third to two thirds of the cases and if so the neoplastic mass frequently occupies only a portion of the cyst wall. These tumors and their cysts of compressed cerebellar tissue are more or less equally distributed between the vermis and the cerebellar hemispheres; often both structures are involved.

Operation (reoperation may be indicated)

To establish tissue diagnosis

To evacuate any cystic formation

To excise all tumor compatible with safety

To correct obstructive hydrocephalus either by tumor excision or by a cerebrospinal fluid short-circuit.

Irradiation

Indicated if tumor excision has not been "complete" in the macroscopic sense.

Chemical Therapy

Not indicated.

There are long term survivals (occasionally up to 20 years) following only solitary cyst evacuation of certain cystic cerebellar astrocytomas which indicates their benign nature. With proper surgical excision cure may be hoped for in perhaps half these cases. German reported that 76 per cent of the patients of the Cushing series survived five years postoperatively.[7]

The Medulloblastoma

Although this tumor usually appears within the fourth ventricle and causes a vermis syndrome predominantly in male children, it does occur rarely in other parts of the posterior fossa in subsequent decades of life, and the patient has a longer survival. The following comments concern the common, rapidly growing childhood tumor, which tends to disseminate throughout the cerebrospinal fluid pathways.

Operation (reoperation rarely indicated)

To establish a tissue diagnosis

To unblock the fourth ventricle or provide a cerebrospinal fluid short-circuit for the obstructed flow

Perhaps (in selected cases) to achieve subtotal excision.

Irradiation

Indicated to the entire neuraxis.

Chemical Therapy

Semi-experimental, via vertebral artery or into the subarachnoid pathways.

Because of the intimate attachments of these vascular tumors to the medulla, a high rate of operative mortality has been associated with attempts at radical excision. Recent experience suggests this may be improved, but current therapy brings only 6 per cent of patients to a three-year survival.[7]

Grant reported a five-year survival of 3.5 per cent of patients surviving operation.[8]

Although the average postoperative survival is brief (15 months), irradiation definitely gives improved and lengthened survival.[5] Of 38 patients who were operated upon and irradiated five or more years previously, Smith and associates reported 11 alive and five of them well.

The Ependymoma

This tumor, usually of the fourth ventricle but occasionally of the cerebral hemispheres and rarely of the cerebellopontile angle, varies from one of well organized epithelial or papillary architecture to a more anaplastic lesion. It is not uncommonly cystic in the cerebrum and about 15 to 20 per cent may calcify in this location. The posterior fossa tumor is usually solid.

When it is located in the cerebral hemispheres involving the lateral ventricles:

Operation (reoperation may be indicated)

To establish tissue diagnosis

To unblock the ventricular system and excise as radically as compatible with preservation of useful life.

Irradiation

Indicated for these tumors.

Chemical Therapy

Semi-experimental, but justifiable trials are indicated for nonresectable tumors.

When located in the midline—fourth ventricle position:

Operation (reoperation may be indicated)

To establish tissue diagnosis

To excise all tumors when compatible with safety to the brain stem

To unblock the obstructed cerebrospinal fluid pathways by tumor excision or short-circuit operation.

Irradiation

Indicated for the incompletely excised tumor.

Chemical Therapy

Semi-experimental only.

These tumors, although considered radiosensitive by some investigators, are found in a broad spectrum from a fairly slowly growing papillary tumor to a rapidly growing mass demonstrating plemorphism and glioblastomatous change. Less than one third of patients surviving operation are alive five years later. Mabon and associates reported that the percentage of patients surviving three years varied from 9 to 79 per cent depending upon the histologic grading of the tumors.

The Oligodendroglioma

This slowly growing solid tumor is located in the cerebral hemispheres or occasionally the optic nerves and calcifies in a high proportion of cases (40 to 60 per cent).

Operation (reoperation may be indicated)

To establish a tissue diagnosis

To remove as much tumor as is possible compatible with survival and preservation of function.

Irradiation

Little evidence of effectiveness.

Chemical Therapy

Not indicated.

This tumor may undergo a change in biological behavior and demonstrate a more rapid growth potential than its long history would cause one to expect, and such change may follow local treatment. German reported that 32 per cent of patients with multiple operations survived five years.[7]

Gliomas of the Brain Stem (Pontine Gliomas)

This tumor, either astrocystoma, spongioblastoma polare or glioblastoma multiforme, involves the major projection pathways and cranial nerve cell masses and fibers. It swells the brain stem and may cause obstruction of cerebrospinal fluid with clinical signs of increased intracranial pressure in about one-third of cases or less.

Operation

To exclude a resectable tumor of the fourth ventricle

To short-circuit any cerebrospinal fluid obstruction

To aspire a cyst or take a biopsy specimen (rarely).

Irradiation

Indicated in almost all cases. If initial improvement occurs, second courses of treatment may be offered.

Chemical Therapy

Semi-experimental, via the vertebral arteries, but its efficacy unknown.

Although three-fifths of such tumors respond temporarily to irradiation in a favorable fashion, the average survival is nine months with an occasional survival two to three years after diagnosis.

The Gliomas of the Thalamus, Posterior Third Ventricle and Corpus Callosum

This deeply placed, midline, usually bilateral tumor comes to attention in a patient with paralytic features, manifestations of pressure, and mental aberrations. It follows a rapid clinical course.

Operation

To verify tissue diagnosis via stereotaxically placed cannulae

To short-circuit cerebrospinal fluid obstruction.

Irradiation

Indicated in most cases.

Chemical Therapy

Unknown as to proper method of application or efficacy but infusion therapy may be justified.

Because of the unfavorable tissue type and location of this tumor, survival is short and "cures" are not attainable.

The Gliomas of the Optic Chiasm and/or Optic Nerve

The oligodendroglioma, astrocytoma and spongioblastoma polare constitute most of the tumors in this location. Many of the chiasm tumors have spread from the third ventricle, but isolated chiasmal and optic nerve tumors appear in the younger age groups, occasionally as one of the protean manifestations of a neuroectodermal dysplasia (von Recklinghausen's disease, tuberose sclerosis, etc.).

For the tumor involving one optic nerve, often with unilateral proptosis and an enlarged optic foramen:

Operation

To establish a tissue diagnosis

To excise the tumor and nerve between the chiasm and the optic globe if the chiasm is not grossly involved.

Irradiation

Indicated if excision is not possible or incomplete.

Chemical Therapy

Not indicated.

For the tumor involving the chiasm:

Operation

To verify the nature and extent of the involvement.

Irradiation

Indicated in almost every case.

Although earlier reports were unconvincing, the use of higher dose courses of irradiation have given rise to some favorable responses.[30] This tumor may be quite slow in growth and the patient may survive for many years even with incomplete excision or without excision.

The Meningiomas

The underlying principle governing the management of these tumors is the mobilization of the best surgical technique for complete excision (occasionally in stages). Such excision often requires wide removal of the dural attachment with dural grafting[26] and bone excision with subsequent cranioplasty, often accomplished at one stage.

Meningiomas in special areas occasionally cannot be completely excised:

1. In the case of tumors that involve the superior longitudinal sinus with incomplete obstruction thereof, resection of all tumor-bearing portions of the dura mater is impossible. If total occlusion of the sinus comes about, excision may be feasible.

2. Extensive hyperostosis and bone infiltration about the sphenoid wings and orbit may create a cranial tumor of such extent that radical excision would be either impossible or too mutilating to be reasonable.

3. Certain tumors at the base of the skull involving the clivus, or large tumors of the tuberculum sellae or vicinity may incorporate structures such as the carotid arteries in a manner to prevent total excision.

Many of these barriers to complete excision may be avoided by early perception and delineation of the tumor and the planning of a full-scale attack at the time of the first definitive operation.

In dealing with the meningiomata, which make up 15 to 20 per cent of primary intracranial neoplasms, the rewards for surgical excellence are high, for although under most favorable conditions a recurrence rate of about 9 per cent is reported, reoperation may be undertaken with opportunity for cure.[23]

The Pituitary Adenomas

1. The non hormone-secreting or minimally secreting chromophobes or mixed adenomas constitute two-thirds of the primary tumors of the hypophysis. They expand the sella turcica and compress normal glandular tissue and extend extrasellarly to involve neighboring structures, notably the visual apparatus. Occasionally the cavernous sinus, temporal lobe, third ventricle, frontal lobes or the interpeduncular fossa may be encroached upon.

For the strictly intrasellar tumor without neural deficit manifested by endocrinologic deficiency or radiologic sellar change:

Operation

Not indicated.

Irradiation

Indicated in full tumor doses with careful neurologic follow-up.

Chemical Therapy

Not indicated.

For the tumor which extends beyond the confines of the sella turcica with neural involvement (particularly visual field involvement).

Operation (reoperation may be indicated)

Subtotal to "total" excision indicated with complete emptying of sella turcica and excision of all tumor capsule compatible with safety for adjacent neural and vascular structures.[17,28]

Irradiation

Indicated if tumor excision is recognized grossly as incomplete.

Chemical Therapy

Except for needed hormonal replacement, no destructive tumor therapy indicated.

2. The hormone-secreting acidophilic tumor manifesting as gigantism or acromegaly with evidence of continued hormonal hypersecretion.

Operation

May prove the best method of eradicating the destructive influence of the acidophilic tissue. (Too few cases as yet to establish the place of operation.)

Irradiation

Conventional therapy is inadequate in managing these tumors but proton beam irradiation has been successful, and local implantation of high energy radioactive isotopes via stereotaxic techniques hold promise.[15]

Chemical Therapy

Destructive therapy not indicated.

Although a recurrence rate of 8 to 10 per cent is recognized after surgical excision, current techniques are offering increasingly more complete excision with very low mortality.[17]

The Craniopharyngioma

This tumor is of highest incidence in the first three decades of life but occurs at any age, is sellar and suprasellar in location and is calcified in over half of cases. It manifests as a mass that causes hypophyseal-hypothalamic deficiency (hypogonadism, impaired growth and diabetes insipidus); if third ventricle obstruction or chiasmal compression is a factor, great care is necessary in planning therapy. Operation and hormonal replacement, if needed, are the only hopes for "cure."

Operation

To confirm tissue diagnosis

To evacuate the frequency encountered cyst or cysts

To excise by tedious teasing of all capsule from its intimate but not intrinsic involvement with adjacent neural and vascular tissue

To relieve obstructed cerebrospinal fluid flow by tumor excision or short-circuiting operation.

Irradiation

Not indicated.

Chemical Therapy

Not indicated.

These tumors have carried a high operative mortality in the past, and firmly attached tumor involving the third ventricle, basilar or carotid arteries must be left behind; but with current techniques total excision is compatible with useful survival.[12]

Pinealomas-Pineal Teratomas

These tumors of the first decades of life (teratomas) obstruct the cerebrospinal fluid pathways, compress the midbrain, and produce secondary endocrinologic imbalance through third ventricle distension.

Operation

To establish tissue diagnosis through stereotaxically placed cannulae

To provide a short-ciruit to cerebrospinal fluid obstruction

To attempt total excision of small, circumscribed lesions in rare instances.

Irradiation

Indicated in almost all such tumors.

Chemical Therapy

Not indicated in its present forms.

Survival rates following treatment by a combination of cerebrospinal fluid decompression and irradiation support this indirect and more conservative management. Horrax reported six out of nine patients alive and well two to 17 years later.[9] Rand and Lemmen reported an average survival of more than five years among 12 patients.[16]

The Neurilemmoma (Neurinoma) of the Eighth Nerve

This tumor is the most common of the cerebellopontile angle and of the posterior fossa of the adult over the age of 30. It arises in a cranial nerve and grows slowly. It paralyzes nerve function and then progresses to involve neighborhood cranial nerves, disturbs cerebellar hemisphere function and eventually distorts the brainstem and obstructs cerebrospinal fluid flow. Treatment is strictly surgical.

Operation

To excise the tumor completely is the goal

To treat through facial-hypoglossal anastomosis any accompanying seventh nerve paralysis following tumor excision.

Irradiation

Not indicated.

Chemical Therapy

Not indicated.

Cure may be expected for these tumors when the meticulous technique of total excision can be offered. Subtotal, intracapsular excision has a place in the very elderly patient or in circumstances which, because of the intimacy of tumor involvement with the vascular supply of the brain stem, prevent excision without undue risk. German reported that approximately 50 per cent of treated patients survived ten years.[6]

The Hemangioendotheliomas and Hemangioblastomas

These tumors of the cerebellum, both midline and hemispheric, are cystic lesions in 80 per cent of cases and may occur as part of one of the familial and hereditarily important neuroectodermal dysplasias. Their association with erythrocytosis makes them especially interesting.

Operation (reoperation may be indicated)

To establish tissue diagnosis

To excise as much tumor mass as is possible compatible with preservation of useful survival

To evacuate tumor cysts if total excision is impossible

To short-circuit around a cerebrospinal fluid obstruction if tumor excision or cysts evacuation does not adequately relieve a block.

Irradiation

Not indicated.

Chemical Therapy

Not indicated.

Because these lesions are frequent posterior fossa tumors of adult life, it is helpful to know that total excision is possible in a high proportion of cases. Olivecroma reported 63 total excisions in 70 patients treated, with ten operative fatalities.[13] Silver and Hennigar reported that 50 per cent of surgically treated patients survived five years.[22]

Dermoid-Epidermoid Tumors

The locations of these tumors are temporal, parasagittal, orbital, parasellar and posterior fossal (midline, cerebellopontile angle and lateral medullary cistern). They are extremely slow-growing lesions but even a small tumor may cause trouble because of a strategic position. They may spread as a carpet of tumor and involve multiple cranial nerves along the base.

Operation

To excise totally is the goal.

Irradiation

Not indicated.

Chemical Therapy

Not indicated.

If total removal of the widespread, thin, desquamating epithelial wall of such tumors is not possible, evacuation of the soft, avascular content is usually followed by prolonged survival.[19]

Paraphyseal-Epithelial Cysts of the Third Ventricle

These are benign cysts that obstruct the interventricular foramen of Monro and produce a hydrocephalus and variable symptom complex. The diagnosis is determined by ventriculography and the therapy is immediate operation and total excision. There is no place for irradiation or chemical therapy.

Miscellaneous Primary Tumors

The neoplasms that are almost a curiosity include the *ganglioneuromas* of the cerebrum, the *sarcomas* of the cerebellum, the *lipomas* of the corpus callosum and tumors of contiguous structures such as *chordomas* of the basisphenoid, tumors of the *glomus jugulare, osteochondromas* and *neoplasms* of the integument including the skull.[27] Tumors invading the intracranial chamber from adjacent areas such as the accessory nasal sinuses are not considered in this discussion.

The *arteriovenous anomaly* is, strictly speaking, not a neoplasm and although important as a cause of hemorrhage, hemiparesis, and epilepsy, will not be considered further. The lesions of inflammatory nature, specific infections, and the dysplasias of bone are also beyond the scope of our consideration here.

Metastatic Tumors

Ten per cent or more of brain tumors cared for in neurosurgical centers are of metastatic nature. They may be discovered by accident as the first indication of cancer elsewhere or they may develop in the course of a recognized primary lesion. They may appear after the primary tumor has been thought to have been eradicated, and under such conditions they rarely are solitary metastatic lesions.

If the tumor is diagnosed without primary tumor having been suspected:

Operation

To establish a tissue diagnosis

To remove the tumor.

Irradiation

May be indicated if the lesion is not resectable.

Chemical Therapy

Indicated if the tumor is not resectable.

If the tumor is a suspected solitary metastatic tumor under circumstances in which the primary tumor has been or can be eradicated:

Operation

To confirm a tissue diagnosis

To excise the tumor.

Irradiation

As in the case of an unsuspected primary tumor.

Chemical Therapy

As in the case of an unsuspected primary tumor.

If the metastatic disease is recognized as disseminated and the brain tumor appears single:

Operation

May be offered for relief of headache and neural impairment, depending on the patient's general life expectancy.

Irradiation

May be offered in palliation unless intracranial pressure is excessive.

Chemical Therapy

Holds promise—carried out via the major arterial supply to the tumor-bearing area.

If the metastatic disease to the brain is multiple as defined by the variety of diagnostic techniques available:

Operation

Not indicated.

Irradiation

May be indicated in selected cases.

Chemical Therapy

May offer the best designed palliation available.

Patients with metastatic carcinoma often have received courses of therapy, either irradiation or chemical administration, that interdict the use of still further therapy when metastasis to the brain appears, but merciful help may on occasion be offered.

The Future

The future lines of investigation that appear most profitable in the pursuit of improved methods of therapy, especially for the gliomas, seem to lie along the avenues (1) of the study of the effects of chemical agents upon experimentally generated animal tumors, (2) the study of methods of homologous and heterologous brain tumor transplantation from animal to animal and man to animal, whereby the genetic identity of the original tumor is not altered by its transplantation and subsequent passage, (3) the study of the growth requirements and responses to altered chemical environment of tumor explanted and grown in tissue culture.[25,29,33]

Conclusion

The currently available methods of attack are effective in the management of the benign, circumscribed or encapsulated tumor. Improved safeguards to life during operation are always sought, but major revisions in surgical technique are unlikely in the near future. Because of incidence and inadequacy of surgical efforts to attain acceptable cure rates, the tumors in the group of malignant gliomas remain the outstanding challenge to the investigators in this important field.

UCLA Medical Center, Los Angeles, California 90024.

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